

EXHIBIT 19



**U. S. DEPARTMENT OF LABOR
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BACKGROUND INFORMATION REGARDING THE ANALYSIS OF INDUSTRIAL TALCS

When OSHA first promulgated its expanded asbestos standard in 1972, it included what was understood to be the occupationally important asbestos minerals. The term asbestos is not a proper mineralogical term. It has been applied for thousands of years to minerals which were obviously fibrous and could be used for spinning and weaving, fireproofing and for composite materials in clays and pottery. It came to be applied to any of the minerals having this gross appearance and use. By the time OSHA promulgated its standard, the commercial definition was limited to chrysotile, Amosite (grunerite asbestos), crocidolite, anthophyllite asbestos, tremolite asbestos and actinolite asbestos. (29 CFR 1910.1001(b)). These were the minerals that were encountered in occupational asbestos exposures.

In addition to these six minerals, there are over one hundred other minerals known to exist in the asbestiform habit (Walter Bank, private communication, 1978). These minerals are not properly known as "asbestos." The fibers contained in these minerals have the same general growth habit and shape as the fibers of the six asbestos minerals. They can be easily parted along their length, and they generally have a high tensile strength both of which give rise to fibers with very high aspect ratios (ratio of the length to width of individual fibers). Without careful mineralogical identification, some of these minerals can easily be misidentified as one of the six asbestos minerals. In addition to any confusion brought to the table by non-asbestos asbestiform minerals, some of the asbestos minerals grow in non-asbestiform habits. When crushed, these minerals will form cleavage fragments which may be much longer than they are wide owing to preferential parting along a preferred axis. These are fibers. But, they are not asbestiform. Fibers of asbestos are asbestiform because they grew that way, not because they were crushed to make them fibrous. Some minerals have different names for the various growth habits they possess. In the case of tremolite, actinolite, and anthophyllite there is no separate name given. The asbestiform varieties must be identified by using the adjective, asbestiform or asbestos, (e.g. asbestiform tremolite).

Beyond the morphological ambiguity, minerals do not occur in exactly the same chemistry throughout the world, or even across an individual deposit. It is possible, with adequate representative samples, to identify a particular mine from which a mineral was removed. The elements present, the temperature, pressure, time, and exposure all contribute to the composition and structure of a given mineral. Along with chemical variations, there also exist structural differences and accidents which occur because of particular conditions present at the formation of the mineral and through subsequent time. A mineral once formed in a process may be changed either rapidly or slowly to another mineral given a proper set of circumstances.

Historically, it has been the analyst's task to sort out, identify and classify minerals according to

a set of optical criteria. The results of these optical tests performed in a polarizing microscope, will identify most minerals. It is not always possible, nor desirable, to perform every test for every particle because the particle is too small to give a result, or only some tests are required where the mineral identification is limited to a small number of possibilities.

This is the case with the asbestos minerals. When determining the type and percent of commercial asbestos minerals, in a product to which it was intentionally added, it is only necessary to determine two of the three major indices of refraction, the sign of elongation, the angle of extinction, and observe that the mineral is birefringent. Where only commercial asbestos is present, there are no serious interferences and this limited set of information is adequate to identify the presence of chrysotile, Amosite, crocidolite, tremolite asbestos, actinolite asbestos and anthophyllite asbestos. If other, asbestiform minerals are present, or if non-asbestiform cleavage fragments of one or more of the asbestos minerals is present, an analyst may encounter difficulty in determining which fibers are asbestos and which are not.

Relatively recently, x-ray diffraction, transmission electron microscopy, microprobe analysis, and scanning electron microscopy have been added to the arsenal of the mineral analyst. These tools allow the analyst to investigate the crystal structure and the chemical content of minerals. They also introduce a new set of confounding information which can confuse and mislead an analyst trained mainly to look for commercial asbestos minerals.

The tremolitic industrial talcs such as those found in New York present a difficult analytical problem. The material has a high component of non-asbestiform tremolite, some mostly non-asbestiform anthophyllite, some massive and some asbestiform talc, some quartz, and some intermediate or transitional asbestiform mineraloids along with traces of other minerals.

This mineral assemblage presents two red herrings for asbestos analysts. This group of products has cleavage fragments of non-asbestos tremolite and anthophyllite which, while meeting the definition used for phase contrast counting (aspect ratio longer than or equal to 3 to 1 and longer than or equal to 5 micrometers), are not covered by the OSHA definition of asbestos. Secondly, there are asbestiform fibers in the products which range in composition from nearly that of anthophyllite to talc. Except for a very few fibers occasionally found to be anthophyllite asbestos, these fibers are generally not covered by the OSHA asbestos standard.

The first problem is complicated by two factors. The first is that cleavage fragments are not covered by federal standard while the most common method used by NVLAPS laboratories requires the inclusion of cleavage fragments. The second is that it may not be possible to determine whether an individual fiber is a cleavage fragment or an asbestiform fiber if it has an aspect ratio less than about 20 to 1. Asbestiform minerals usually have average aspect ratios in excess of 100 to 1, while cleavage fragment distributions typically have mean aspect ratios below 10 to 1. Some help is afforded by the information in OSHA method ID-191 or of Bureau of Mines Information Circular IC8715. These document some of the analytical clues. A determination for a mineral is usually made if the average aspect ratio appears to be very large or the cleavage fragments are generally free of longitudinal striations or they are acicular or other non-asbestiform fiber shape.

The second problem leading to false identification of asbestos in these talcs is the presence of the

asbestiform intermediate or transitional fibers. It is thought that these fibers were once anthophyllite and have undergone a mostly completed retrograde metamorphosis to talc. Their appearance is strikingly asbestiform. The selected area diffraction patterns obtained in the usual manner for asbestos analysis appear almost like those of anthophyllite asbestos. This is due to the peculiar crystal structure of the talc in this mineraloid. If one looks directly at the crystal structure using high resolution electron microscopy, the structure of the fiber can be seen to consist of randomly distributed chains of amphibole (anthophyllite), talc, and pyroxene chains. The individual fibrils (smallest asbestiform fiber structure) are constructed of a fine mixture of minerals on a scale too fine to be resolved by a light microscope. This particular arrangement of atoms gives a diffraction pattern with enough amphibole character to mis-identify it as anthophyllite.

The same structure also lead to erroneous identification of the chemistry. In pure end-member talc, there are 6 magnesium atoms for every 8 silicon atoms. In the magnesian end member for anthophyllite, there are 7 magnesium atoms for every 8 silicon atoms. The EDX spectra for such fibers are almost indistinguishable by observation alone. It is only by very careful calibration and quantitative analysis that an analyst is able to differentiate these intermediate fibers from anthophyllite. The average analysis for these fibers puts the concentration of magnesium at between 6.5 and 6.8 magnesium atoms per 8 silicon atoms. A fiber having a magnesium population at or above 6.8 would be considered to be anthophyllite if it has a corroborating Selected Area Electron Diffraction (SAED) pattern, with an internal standard (gold), to be indexed as anthophyllite.

It is generally observed that PLM laboratories do not always perform the TEM because they see the cleavage fragments and call them asbestos. Conversely, TEM laboratories do not perform the PLM and call the fibers seen anthophyllite with some tremolite.

When the techniques are combined, it is noted that the asbestiform fibers have indices of refraction almost exclusively below 1.592. Also, there are some cleavage fragments of tremolite having indices of refraction above that in the range 1.620 and very occasionally a fiber appearing to be asbestiform with indices of refraction in the range of 1.620 which is probably anthophyllite. It is rare to see a fiber clearly identifiable as anthophyllite in the PLM.

Conversely, when viewed in the TEM, almost all of the fibers appear to be anthophyllite using the usual techniques of asbestos analysis applied to the asbestos abatement industry. The diffraction patterns are sufficiently similar that using only pattern recognition, a mistake is made. The usual check on this mis-identification is to look at the EDX chemistry. It is so similar to the anthophyllite that it only confirms the identification of anthophyllite.

What TEM says is there is denied by PLM. The cure, in this case, is careful analysis. Pattern recognition for SAED contains a number of pitfalls which should be avoided by indexing wherever practical. Whenever general mineralogical materials might be present beyond the commercial asbestos minerals, it is very important to step beyond the short set of identification criteria and fully identify the fibers present.

In summary, the difficulty and novelty of the minerals present and the complexity of the regulatory environment led to an identification of asbestos where none exists. The relative risk of exposure to non-asbestos asbestiform minerals was not addressed in any of this discussion and inclusion or non-inclusion of any mineral should not be taken as a statement of risk by OSHA.